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Global Broadcast Service (GBS) Blockage Assessment for USS *Coronado* (AGF 11)

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ADMINISTRATIVE INFORMATION

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JA

EXECUTIVE SUMMARY

This report examines the impact of USS *Coronado's* two Global Broadcast Service (GBS) topside antenna locations on the availability of broadcast services. Blockage in the present locations limits *global* average line-of-sight availability (GALA) to 83.7% in calm seas, and to 78.3% and 68.2% in Sea States 4 and 6, respectively. However, the *local* average line-of-sight availability (LALA) for these topside locations drops to ~50% in large regions in the ship's area of responsibility (AOR) and to ~10% in areas around the subsatellite point. Moving one or both of the antennas to alternative locations can improve these results. This report also presents GALA and LALA results for a proposed new pair of antenna locations for which the LALA never drops below 81.4% at any point in the field-of-regard of the UHF Follow-On (UFO)/GBS satellites for Sea State 6. Since associated topside electromagnetic compatibility (EMC) studies have been completed with positive results, we recommend that *Coronado's* GBS antennas be moved to these new positions.

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1. INTRODUCTION

On many of today's warships it is impossible to find a single location for a satellite communications (SATCOM) antenna that provides an unobstructed view of the entire sky. Therefore, it is often necessary to install a dual-antenna system to support a shipboard SATCOM terminal. An example is the Global Broadcast Service (GBS) shipboard antenna system (SAS) on the Third Fleet command ship, USS *Coronado* (AGF 11).

The initial installation locations of the GBS antennas on *Coronado* suffer from a large amount of superstructure blockage. This has limited the performance of the GBS system on *Coronado* to a level considerably below what it could be if the blockage situation was better.

This report takes a quantitative look at the GBS blockage situation on *Coronado* with regard to both the present GBS antenna locations, and new locations that have been proposed as part of an integrated topside "overhaul" for the ship. In doing so, this report introduces a new figure-of-merit for describing the degree of blockage: average line-of-sight availability (ALA). Also included in the report are some observations of GBS signal fading associated with the blockage of the present antenna locations, and some detailed examinations of specific blockage-related trouble reports from the ship.

2. THE PRESENT GBS BLOCKAGE SITUATION ON *CORONADO*

The potential for blockage problems with the original locations assigned for the GBS antennas on *Coronado* was recognized while the topside installation proceeded in January 1999 (Axford, 1999a). Figure 1 is a photograph of these locations, which are up on the main mast. Figure 2 shows individual blockage diagrams for these locations. Figure 3 shows a composite blockage diagram for the pair. The blockage adaptation model (BAM) data in these plots were derived from theodolite surveys of *Coronado's* topside. The BAM data include a 2-degree "buffer zone" about the actual topside obstructions in order to give some margin to the GBS dual-antenna system handover algorithm. Appendix A provides further discussion of these buffer zones.

Figure 1. The GBS antenna locations, symmetrical about the main mast, on *Coronado*.

From the blockage diagrams in figure 2 and figure 3, it is clear that the degree of blockage is "severe," and one could conclude "when the satellite of interest is above ~55 degrees elevation, it will be blocked on ~50% of all headings." However, the blockage diagrams alone do not give a clear indication of how well the antenna system can communicate with a given satellite when the ship is in a particular region of the world. The following section presents additional aids for assessing the operational impacts of blockage on shipboard SATCOM systems.

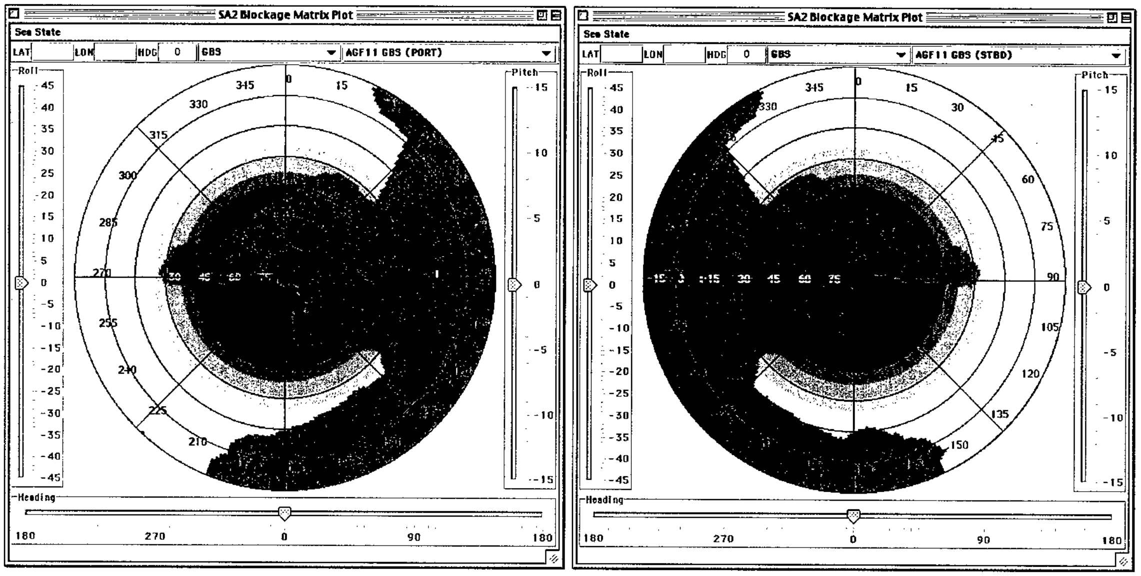


Figure 2. Individual blockage diagrams for the GBS antennas on *Coronado* in the locations shown in figure 1. The data used to make these plots are in the *blockage adaptation model* (BAM) files that reside in the GBS SAS antenna control unit aboard *Coronado*.

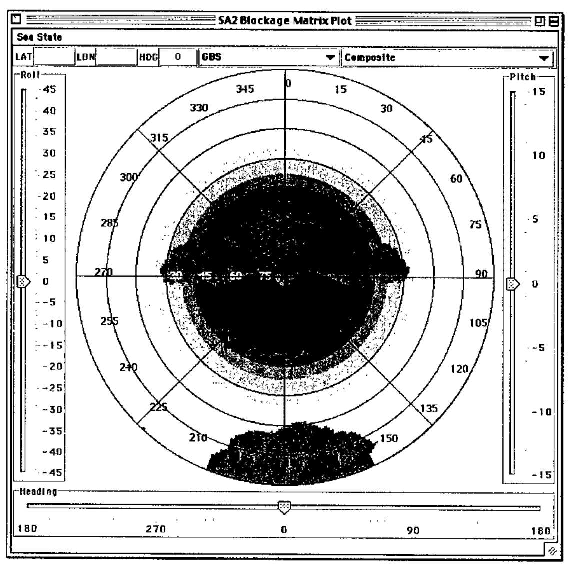


Figure 3. Composite blockage diagram for the GBS antennas on *Coronado* in the locations shown in figure 1. Gray shading indicates look angles blocked from the view of *both* antennas.

3. FIGURES-OF-MERIT DESCRIBING BLOCKAGE

This section presents figures-of-merit (FOMs) for quantifying the amount of blockage associated with topside SATCOM antenna installation locations. While the first FOM is well known, the second is believed to be new.

3.1. PERCENTAGE OF SKY UNBLOCKED (PSU)

The most widely used FOM for blockage is simply the percentage of sky that is unblocked above a certain elevation angle.* (Often, this FOM is stated as the percentage of sky that *is* blocked. However, this report adopts the convention that larger FOMs represent situations that are more desirable.) The percentage-of-sky-unblocked (PSU) FOM is often used to compare the relative merits of candidate shipboard SATCOM antenna locations. In the case of the present GBS SAS locations on *Coronado*, the PSU FOM is a single number representation of figure 3.

Table 1 presents the PSU FOMs corresponding to figure 3 for calm seas, and Sea States 4 and 6, for minimum elevation angles of 0 and +10 degrees. The PSU FOM decreases when a ship's pitching, rolling, and yawing motions are considered because the amount of effective blockage is increased by the superstructure periodically moving through a greater number of potentially desired lines-of-sight to satellites. Strictly speaking, "unblocked" means "never blocked" as the ship moves. This report uses the models reported in McDonald (1993) to describe a ship's motion as a function of Sea State.

Table 1. PSU FOM values for the antenna blockage diagram shown in figure 3 and, in parentheses, for the antenna blockage diagram shown later in figure 7.

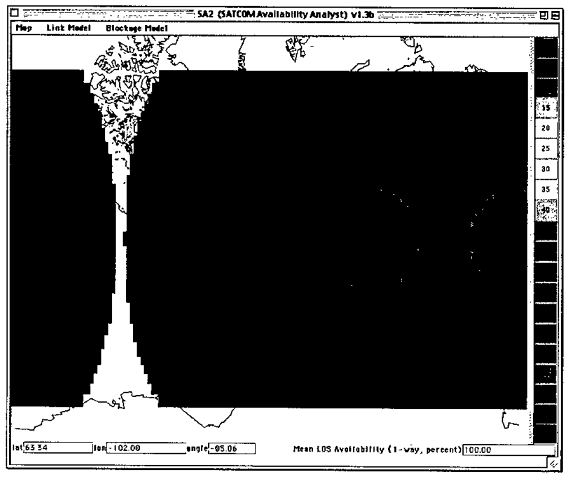
Min. El. Angle	Calm Seas	Sea State 4	Sea State 6
0	72.4% (99.4%)	65.7% (98.9%)	57.8% (97.9%)
+10	70.3% (99.9%)	62.9% (99.6%)	54.2% (99.1%)

3.2. AVERAGE LINE-OF-SIGHT AVAILABILITY (ALA) TO A DESIRED SATELLITE

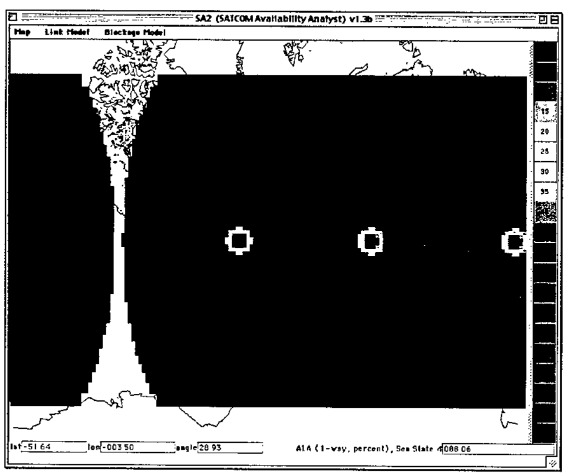
Although the PSU FOM is useful in selecting one antenna location over another on a particular ship, it says nothing absolute about how either location will serve the ship with a given satellite in any region of the world. Many ship captains say that there have been times when his or her choice of heading was dictated by whether or not a particular shipboard SATCOM antenna system could "see" a desired satellite. Thus, a reasonable question to ask is, at a given position on the earth, for a particular satellite of interest, what percentage of headings will result in unblocked views? This is precisely the definition of local average line-of-sight availability (LALA). Unlike PSU, LALA is defined for a particular satellite and changes with the ship's position on the earth. It is, therefore, useful to plot LALA with a color map. Like PSU, LALA decreases when the ship's motion due to Sea State is considered.

* This report uses a resolution of 1 degree in both azimuth and elevation in calculating the PSU FOM. The zenith point (90° elevation) is counted only once. All other elevation angles have 360 associated azimuth angles.

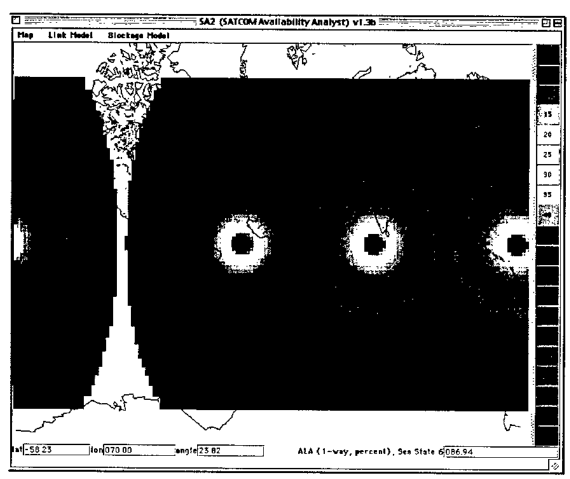
Figure 4 presents three LALA maps for *Coronado's* initial GBS antenna locations in calm seas, in Sea State 4, and in Sea State 6.* It is interesting to note the high degree of LALA variability with Sea State for UHF Follow-On (UFO) 8 in Hawaiian waters. About 80% of all headings there are unblocked in calm seas, but only about 45% are unblocked at Sea State 6. The figure caption also presents some global ALA (GALA) results. GALA is defined as the average LALA value within the field-of-regard of the entire satellite system. In this case, it is calculated over the combined field-of-regard of UFOs 8, 9, and 10. The LALA map is a useful planning tool showing which world regions are problematic for a given antenna system and satellite constellation pairing.



a. Calm seas, Global ALA (GALA) = 83.7%



b. Sea State 4, GALA = 78.3 %



c. Sea State 6, GALA = 68.2%

Figure 4. Plots of local average line-of-sight availability (LALA) for *Coronado's* initial installation GBS antenna locations (i.e., corresponding to the composite blockage diagram in figure 3.) The satellite chosen for any location cell (2.5 degrees on each side) on the earth, UFO 8, 9, or 10, is the closest one to the cell.

* These plots show LALA for locations with ≥ 0-degree elevation to the UFO 8, 9, and 10 nodal crossings. GBS was designed for ≥ 10 degrees, but spacecraft performance enables routine operations at lower elevation angles.

It is interesting to compare the calm seas results shown in table 1 with those shown in figure 4. The former might appear to be "not too bad," but they give no indication of the negative operational impacts that are clearly shown in figure 4.

4. PROPOSED ALTERNATIVE LOCATIONS FOR *CORONADO'S* GBS ANTENNAS

It is clear from figure 4 that the operational performance of the GBS SAS on USS *Coronado* will continue to be severely limited throughout a significant portion of her area of responsibility (AOR) until at least one antenna is relocated. Stimulated by the experiences documented in Axford (1999b), which are described in detail later in this report, the Space and Naval Warfare Systems Command (SPAWAR) PMW 176-4 searched for new GBS antenna locations for *Coronado*. This section documents the history of this search. Fortunately, it appears that new locations have been identified that would greatly improve the blockage situation.

4.1. AN INFORMAL PROPOSAL (DECEMBER 1999)

In early October 1999, SPAWAR PMW 176-4 asked the Naval Sea Systems Command (NAVSEA) PMS 377 for proposals for new GBS antenna locations for *Coronado*. By December 1999, NAVSEA informally proposed moving one of *Coronado's* GBS antennas (Axford, 1999c). As shown in figure 5, this proposal would have moved the port-side GBS antenna off of the main mast and kept the starboard side antenna in its present location on the main mast. A composite blockage plot for the proposed location set in figure 5 shows that it eliminates the overhead blockage problem, but there would still be some blockage directly aft. This aft blockage would continue to plague *Coronado* in her home waters off the coast of Southern California,* but only on headings that put UFO 8 directly astern.

Although NAVSEA's informal proposal of December 1999 was thought to be reasonable for GBS, it did not address the integrated topside problem of improving the blockage situation for *Coronado's* entire suite of command, control, communications, computers, and intelligence (C^4I) antennas. In April 2000, a more comprehensive proposal emerged.

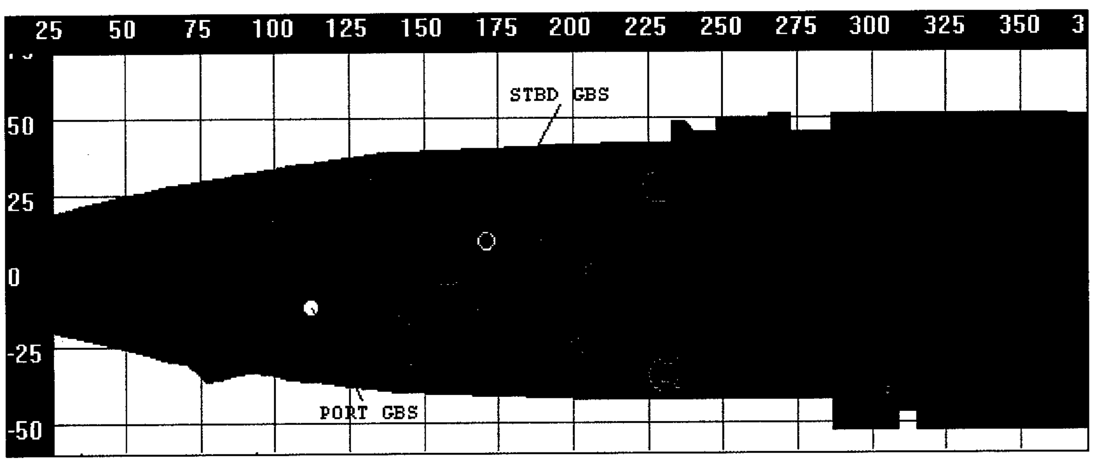


Figure 5. Informal NAVSEA proposal of December 1999 for a new GBS antenna location pair for USS *Coronado*. Presently, the port-side antenna is also on the main mast, symmetrically opposing the starboard antenna (see figure 1).

* In these waters, UFO 8 appears at elevation angles ranging from ~4 to ~11 degrees.

4.2. AN INTEGRATED TOPSIDE SOLUTION FOR *CORONADO* (APRIL 2000)

In April 2000, PMW 176-4 became aware of an effort led by Yvette Tanious, Combat System Integration Manager with PEO EXW (NAVSEA PMS 377H13). Her objective was to perform a comprehensive topside survey of *Coronado* with the aim of proposing an integrated C^4I antenna configuration that would take advantage of the planned removal of the AN/SPS-40 (Tanious, 2000). Thereafter, SPAWAR PMW 176-4 suspended efforts to pursue the proposal described in Axford (1999c).

The preliminary details of the integrated topside overhaul for *Coronado* were first made available in Tanious and Kluis (2000), in which it was stated that "some additional analysis is required to ensure electromagnetic compatibility between existing and projected topside system installations." Subsequently, Day and Kluis (2000) reported that the electromagnetic compatibility studies for the GBS antenna locations proposed in Tanious and Kluis (2000) had been completed with positive results. Along with showing several other *Coronado* C^4I antenna systems, figure 6 indicates the GBS antenna locations first proposed in Tanious and Kluis (2000) and recommended in Day and Kluis (2000). Note that both of the new GBS antenna locations are off of the main mast. Figure 7 shows individual blockage plots for each of the new GBS antenna locations, and figure 8 shows a composite blockage plot for the pair. These should be compared with figure 2 and figure 3. Figure 9 shows the LALA plots associated with the composite blockage plot in figure 8. Comparing these LALA plots with those in figure 4 clearly shows that the new locations would, for all practical purposes, eliminate *Coronado's* GBS blockage problems.

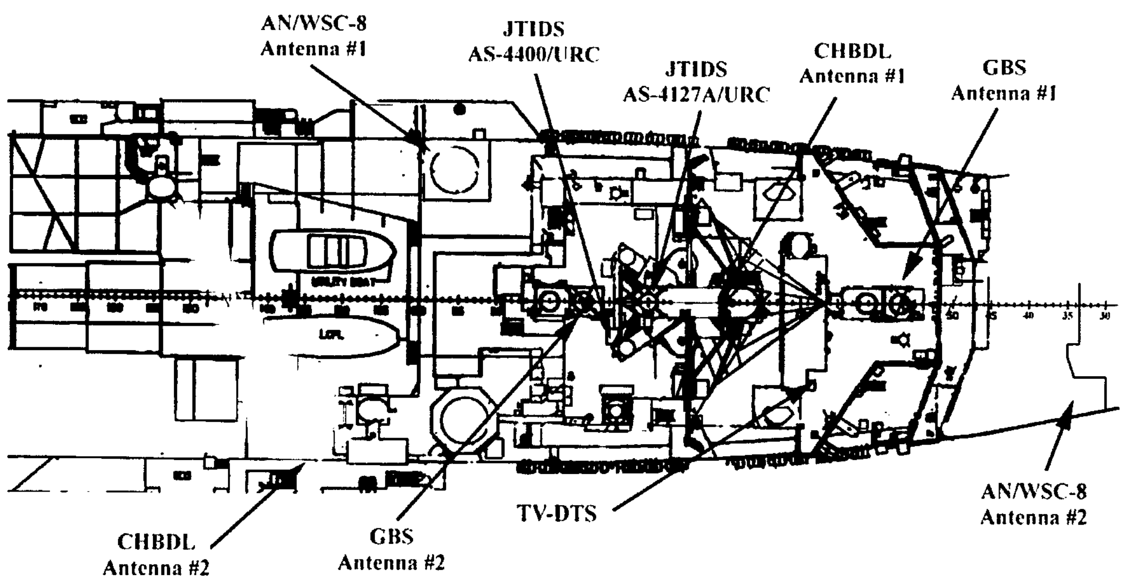


Figure 6. Plan view of recommended new C^4I antenna locations for *Coronado* (Day and Kluis, 2000).

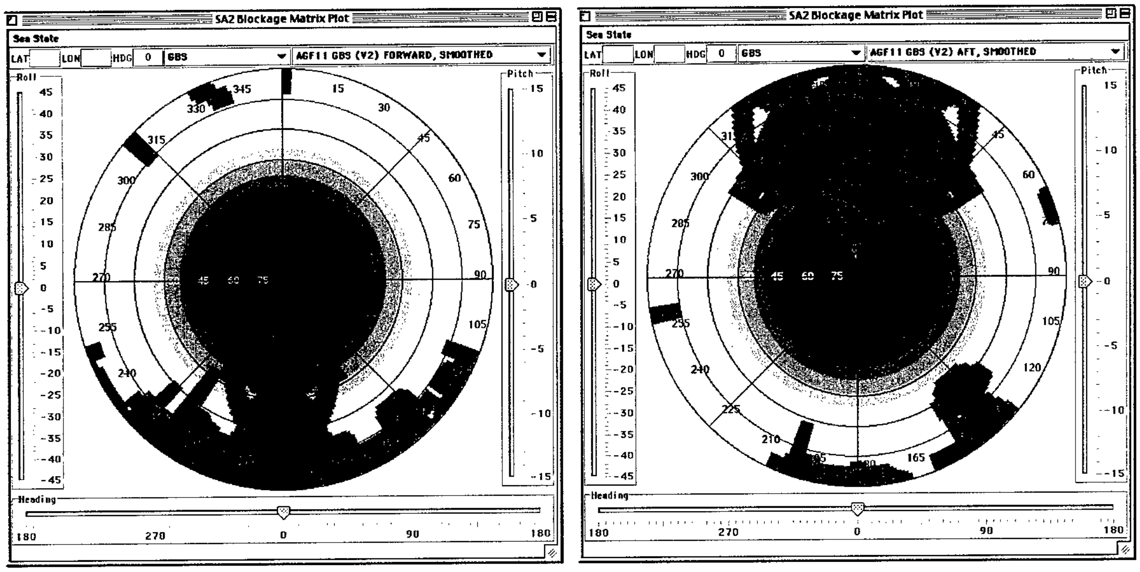


Figure 7. Individual blockage diagrams for the GBS antenna locations proposed in Tanious and Kluis (2000).

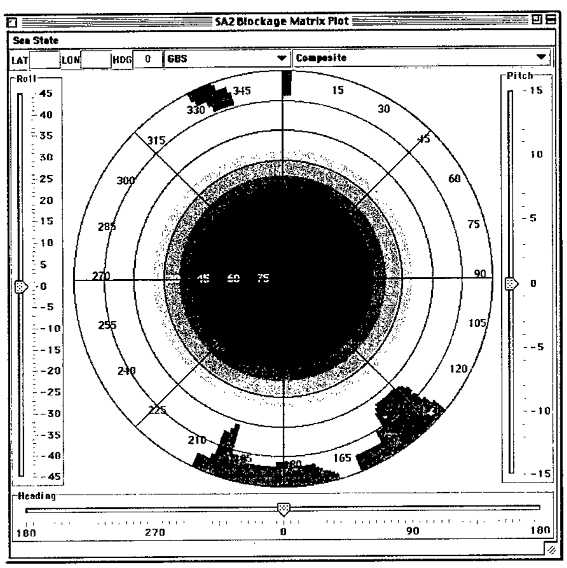
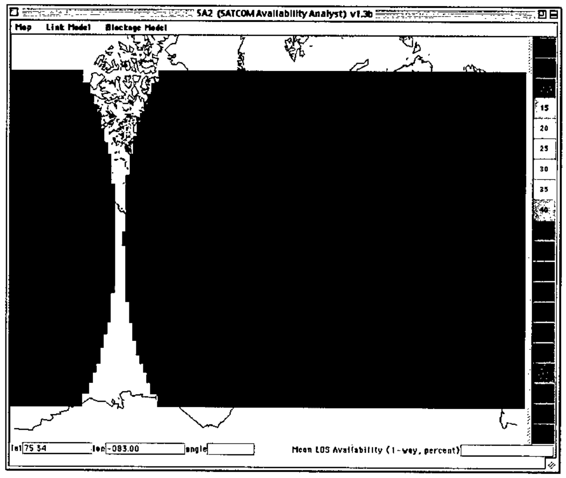
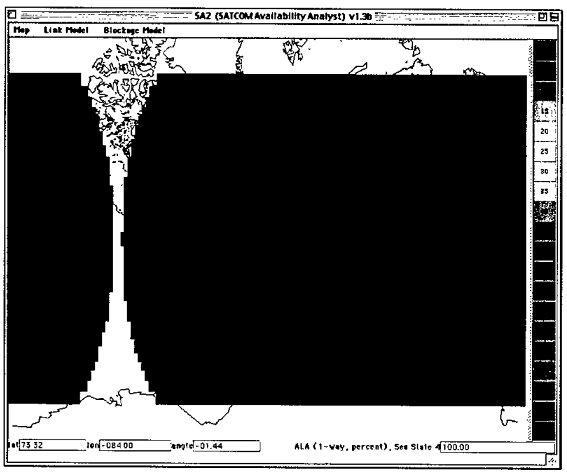


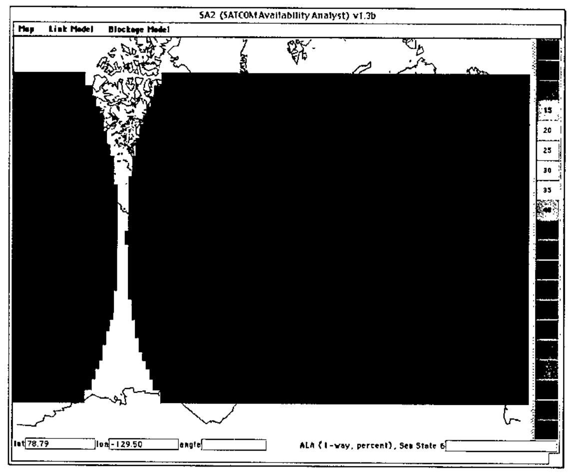
Figure 8. Composite blockage diagram for the GBS antenna locations proposed in Tanious and Kluis (2000).



a. Calm seas, Global ALA (GALA) = 99.3%.



b. Sea State 4, GALA = 98.7%



c. Sea State 6, GALA = 97.5%

Figure 9. Plots of local average line-of-sight availability (LALA) for the new GBS antenna locations for *Coronado* (proposed in Tanious and Kluis [2000]). These plots should be compared with those in figure 4.

5. OPERATIONAL PROBLEMS CAUSED BY GBS BLOCKAGE ON *CORONADO*

This section takes a detailed look at specific problems observed on *Coronado* resulting from the extensive blockage shown in figure 3. The best-documented episode took place while in port at Pearl Harbor.

5.1. GBS SIGNAL FADING WHILE IN PORT AT PEARL HARBOR, HAWAII

When *Coronado* is in port at Pearl Harbor, she is almost always at Pier M1 (21.351N, 157.943W), port side to, which puts the ship's heading at 152 degrees (see figure 10). The GBS satellite UFO 8 is in a geosynchronous orbit with an inclination of ~5.5 degrees. From Pier M1, Pearl Harbor, it appears at elevations ranging from 43.7 degrees to 50.9 degrees and azimuths from 231.8 degrees to 245.9 degrees. The port-side GBS antenna's view of UFO 8 is completely blocked when the ship is docked as shown in figure 10.

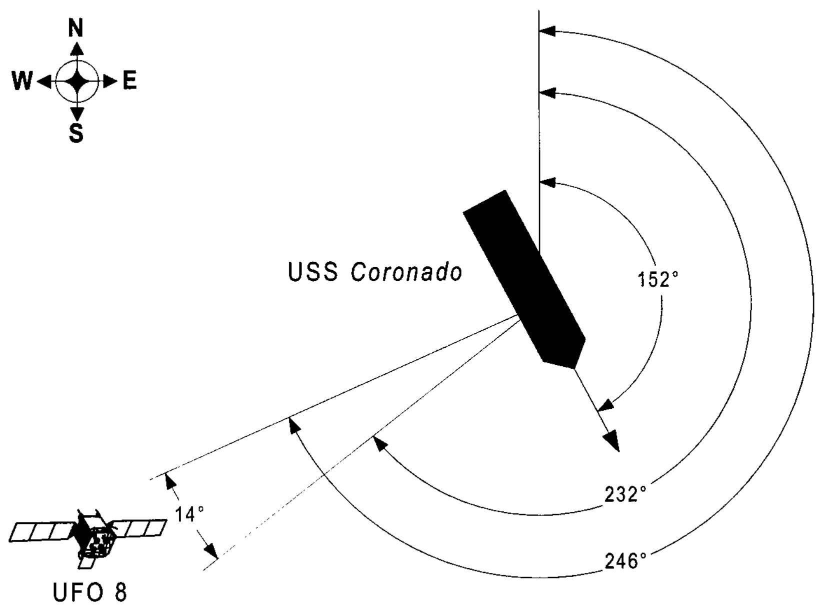


Figure 10. *Coronado's* usual docked position at Pearl Harbor, showing the diurnal range of azimuthal pointing angles to the GBS satellite UFO 8.

5.1.1. Measurements Taken in July 1999

The first time that *Coronado* docked at Pearl Harbor after the installation of her dual-antenna GBS SAS was from 0900 HST, 30 June to 1430 HST, 9 July 1999. This period was during a portion of the GBS "Increment One Enhanced" (I1E) Performance Test, which is summarized in Axford (1999d).

Figure 11 presents a composite of received GBS SAS signal-to-noise-ratio (SNR) measurements recorded during this 1999 in-port timeframe. The fades are due to UFO 8 periodically moving "behind" the overhead superstructure as shown in figure 12. Although the variations in received signal level occur gradually as the blocking superstructure moves in and out of the antenna's field of view, the BAM data give a binary indication of blockage (also shown in figure 11.) In spite of the "blocked" indication, sometimes the SAS tracked through the fades, but sometimes it did not. Thus, it was necessary to compile data records from several days to produce the SNR trace in figure 11. The SAS was not manned full-time during the in-port period, and therefore, it was not possible to manually command it to re-acquire after every loss-of-track event.

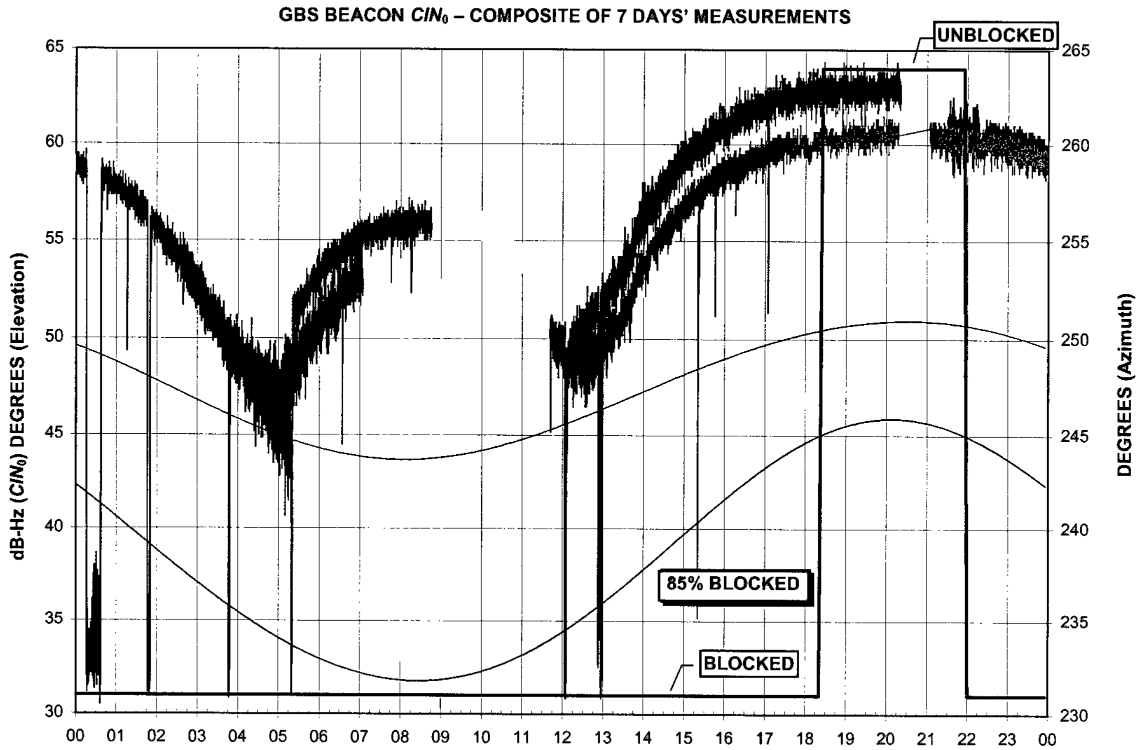


Figure 11. Composite of GBS received beacon signal-to-noise-ratio (SNR, actually C/N_0) observations made from Pier M1 in Pearl Harbor from USS *Coronado* on 2 through 8 July 1999 (from Axford [1999b]). The horizontal axis is hour of day. Also shown are azimuth and elevation pointing angles to UFO 8 from the ship for the same time period (ignoring the slight day-to-day variation in time). Also shown is the GBS SAS BAM blockage indication (starboard-side antenna).

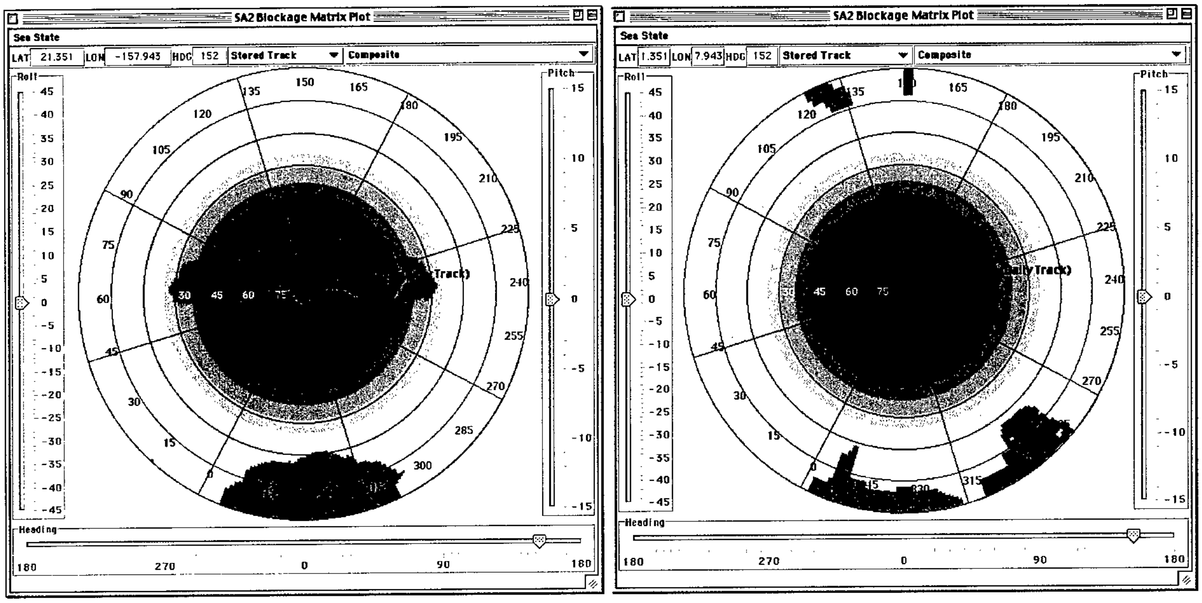


Figure 12. Left: Blockage plot for *Coronado's* original GBS antenna locations and UFO 8 when docked as in figure 10 (see also figure 11). Also shown is UFO 8's diurnal track. Red indicates "blocked," green indicates "unblocked" according to the SAS BAM. Right: Blockage plot for the new antenna locations (section 4.2) and UFO 8, same docking location.

5.1.2. Impacts to GBS Availability in RIMPAC 2000

Almost 1 year after the measurements reported above were collected, *Coronado* was back at Pearl Harbor, docked again as shown in figure 10, supporting the RIMPAC 2000 exercise from the pier. Appendix B presents a chain of e-mail messages that indicate *Coronado* was again experiencing GBS blockage problems during June 2000. Although to *Coronado's* Radio Officer it seemed as if the percentage of time spent in a blocked condition was "99%," it was actually closer to 85%, (see figure 11). It is understandable that it may have seemed like 99% because, unfortunately, the SAS does not automatically re-enter acquisition mode after a period of signal outage. Also, it does not currently give a timely or obvious indication at the operator interface unit (OIU) beyond the beacon SNR when it has lost track, which would cue a manual command to re-acquire. SPAWAR PMW 176 is working with the GBS SAS supplier to make improvements that address these weaknesses. Furthermore, moving *Coronado's* GBS antennas to the positions discussed in section 4.2 will eliminate the UFO 8 blockage problems in Pearl Harbor (see right side of figure 12).

5.2. GBS BLOCKAGE WHILE IN-TRANSIT FROM PEARL HARBOR TO SAN DIEGO

Coronado reported outage problems with the GBS SAS during her return transit from Pearl Harbor to San Diego on 6 July 2000 (Sweigart, 2000a). To determine the possible role of blockage in these outages, on 7 July, SPAWAR PMW 176-4 recommended that *Coronado* be requested to record the following data each time she lost acquisition/re-acquired (Perez, 2000):

a. Date/time of outage (length of outage)

b. Position, Heading

c. Elevation/Azimuth to UFO 8

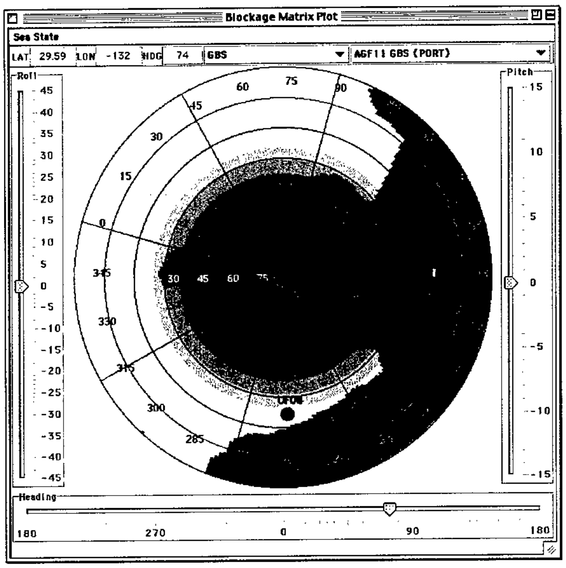
d. Spotbeam being downlinked (because two were available to the ship)

e. Data rate being downlinked

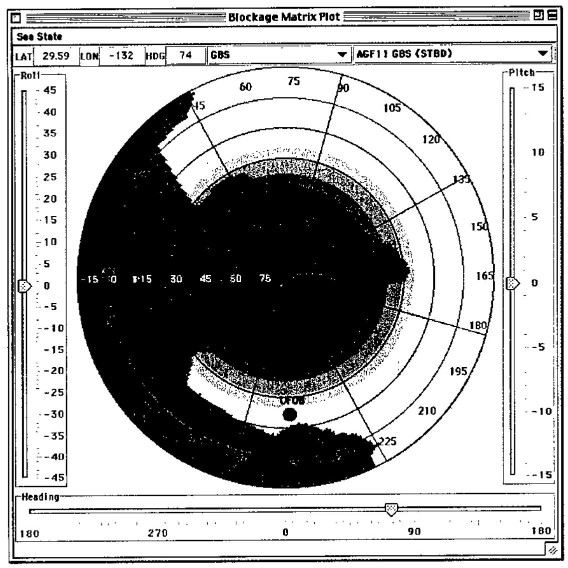
On 8 July, e-mail (Sweigart, 2000b) was received in response to Perez (2000) and included as an attachment the GBS SAS dayfile (Appendix C). This dayfile indicates that the SAS may have been experiencing problems of its own on 6 July 2000 that had nothing to do with blockage. See, for example, the *APU critical fault* at time 21:57:04. However, the accuracy of the indications recorded in the SAS dayfile is in doubt. This doubt stems from the fact that, as reported in Hedrick (2000), the ship was able to restore normal operation of the SAS by shutting it down and re-entering "all associated Navigation/Tracking data." In other words, it appears that stale positional data in the SAS may have played a role, but it does not appear that there was a hardware failure, as the dayfile seems to indicate. SPAWAR PMW 176-4 is addressing the accuracy of the indications recorded in the dayfile with the GBS SAS supplier. Because *Coronado* did not provide positional or heading data for 6 July 2000, it was not possible to determine if blockage was also a factor in the reported outages on that particular day.

Further information in response to Perez (2000) was received in message R111106Z (2000) in the form of the data included here as Appendix D. Unfortunately, these data do not include headings. Therefore, in analyzing them, it was assumed that *Coronado's* heading was the great circle heading toward San Diego (32.79N, 117.15W) from the given position. Figure 13 presents the blockage diagrams that correspond to the final two position reports in message R111106Z (2000), which are 780 and 150 nautical miles, respectively, from San Diego. At these positions on the great circle headings toward San Diego, UFO 8 appears almost directly astern. This is a problematic relative location for *Coronado's* initial installation GBS antenna positions when the satellite of interest is below ~15-degree elevation as is clear from figure 3. Somewhere between the last two position reports in message R111106Z (2000), (exactly where would have depended on Sea State), GBS antenna blockage became a definite problem for *Coronado* as she headed for San Diego (see figure 13). Moving *Coronado's* GBS antennas to the positions discussed in section 4.2 will reduce this problem.

10-JUL-20000, 30N, 132W, HEADING 074

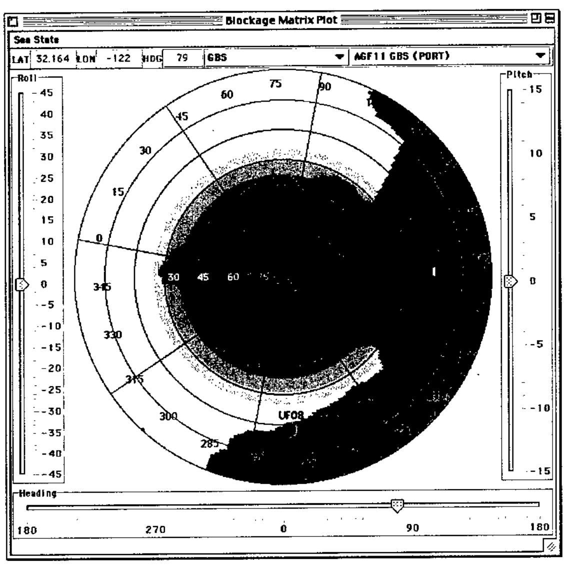


PORT-SIDE ANTENNA

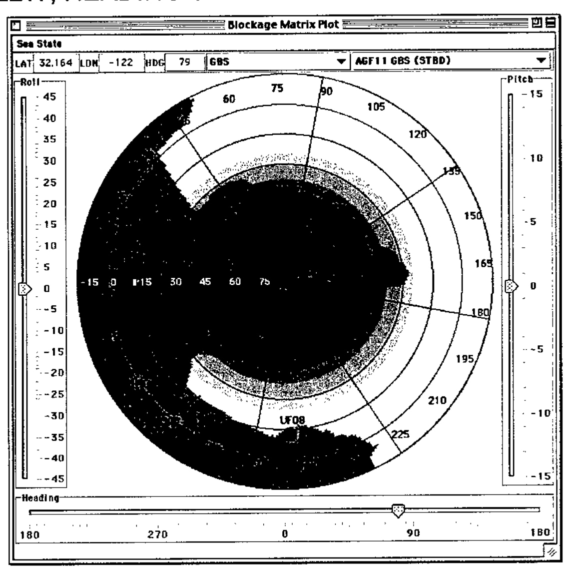


STARBOARD-SIDE ANTENNA

11-JUL-2000, 32N, 122W, HEADING 079



PORT-SIDE ANTENNA



STARBOARD-SIDE ANTENNA

Figure 13. Blockage plots for the final two position reports in message R111106Z (2000).

6. SUMMARY AND RECOMMENDATIONS

Commander, Third Fleet's report on the performance of GBS during the transit from San Diego to Hawaii, during RIMPAC 2000 in Hawaii, and during the return transit to San Diego is given in message R111106Z (2000). It states that "[The GBS] system has thus far proven its reliability in providing planned products, live video feed and has demonstrated strong potential for future interoperability." In spite of the problems on which this report is focused, Third Fleet and USS *Coronado* recognize the critical contribution that GBS will make to DoD's communications infrastructure for deployed forces. The aim of this report is to make clear the extent to which the present antenna blockage situation on *Coronado* limits her ability to make full use of GBS within her AOR. This report has also presented a solution for the GBS blockage problems that we hope will be implemented before *Coronado* supports another major exercise in Hawaiian waters. In the absence of any known reasons otherwise, we recommend that the topside overhaul detailed in Day and Kluis (2000) be undertaken and completed as soon as possible.

Section 3.2 of this report introduced a new figure of merit (FOM) for describing the operational impact of superstructure blockage in shipboard SATCOM antenna installations: average line-of-sight availability (ALA). The ALA FOM was calculated and presented with the SATCOM Availability Analyst (SA2) software tool (originally known as the "GBS Data Mapper") that was introduced in Fitzgerald and Bostrom (2000). Since its introduction, the graphical display capabilities of SA2 have proved invaluable in facilitating the presentation of the results of complex analyses in an intuitively satisfying manner. SA2 has recently been used to analyze and present the blockage situation for the International Maritime Satellite (INMARSAT) High Speed Data (HSD) shipboard SATCOM system on the CG 47 and DDG 51 surface-combatant classes to the Commanding Officer of the Space and Naval Warfare Systems Command (Colvin, 2000). There are also plans to employ SA2 to analyze and display the superstructure blockage situation for all of the SATCOM systems planned for USS *San Antonio* (LPD 17).

7. REFERENCES

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R111106Z JUL 00. FM COMTHIRDFLT TO SPAWARSYSCEN SAN DIEGO CA//PMW176//, SUBJ/GLOBAL BROADCAST SYSTEM (GBS) PERFORMANCE//.* (See also Appendix D.)

Sweigart, R. 2000a. (CWO2, USN, Radio Officer, USS *Coronado* [AGF 11]), "Re: Support," E-mail correspondence to Mike Bellando (Raytheon C^3I Systems, Global Broadcast Service, Satellite Broadcast Manager Pacific), USS *Coronado*, underway between Pearl Harbor and San Diego, (6 July).*

* For further information, contact Roy Axford.

** now SSC San Diego

Sweigart, R. 2000b. "GBS," E-mail correspondence to Alan Stewart (GBS System Engineer, SSC San Diego, D621), USS *Coronado*, underway between Pearl Harbor and San Diego, (8 July).* (GBS SAS dayfile from 6 July 2000 included here as Appendix C.)

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* For further information, contact Roy Axford.

APPENDIX A: BLOCKAGE DATA BUFFER ZONES

As noted in section 2, the theodolite survey data for the current shipboard antenna system (SAS) positions aboard *Coronado* have been "padded" by 2 degrees to reflect the fact that the SAS initiates antenna handover *before* the boresight of the antenna is actually obscured. In other words, the Blockage Adaptation Model (BAM) data are used to trigger handover when the boresight of the active antenna comes within 2 degrees of an obstruction. This appendix presents percentage of sky unblocked (PSU), *local* average line-of-sight availability (LALA), and *global* average line-of-sight availability (GALA) results when a similar smoothing process is applied to the blockage matrices for the proposed SAS positions introduced in section 4.2.

A simple operator similar to a classical dilation operator (3 by 3 kernel) was applied to the theodolite survey data for *Coronado's* proposed new Global Broadcast Service (GBS) antenna positions. This process replaces any unblocked 1 degree by 1 degree matrix element with the logical "OR" of its eight neighbors, a "1" indicating an obstruction in that element. This operator was applied in an iterative fashion, twice. The first pass has the effect of replacing a "line" of 1-degree thickness with a line of 3-degree thickness. The horizontal *and* vertical extent of the *smallest* obstruction becomes 3 degrees. This is described below as 1-degree padding. The second pass replaces a line having an original thickness of 1 degree with a line of 5 degrees, and is referred to here as 2-degree padding.

Figure A-1 compares the original theodolite survey and smoothed matrices for the proposed new antenna positions. Although the forward and aft plots, when compared with their raw versions, appear quite different to the eye, the number of pixels (or 1 degree by 1 degree cells) changed is small, relative to the total number of pixels in the plot. The plots contain 360 by 91 or 32,760 cells; 1.0% of them, therefore, would be 328 cells. Although the changes in the individual (fore and aft) matrices are on this order, the lack of significant overlap between the plots means that only a very small number of pixels are changed in the composite plots. Moreover, most of the pixels changed are below the 0-degree elevation ring shown in purple. Therefore, the PSU figures, shown in table A-1, do not differ greatly. Table A-2 compares the GALA and minimum LALA figures. These two tables demonstrate that the impact of smoothing on either PSU or GALA figures is very small, and that the presence or absence of smoothing in the data for the current positions is of no significance when comparing the present and proposed new GBS antenna positions on *Coronado*. Minimum LALA, however, is affected more strongly.

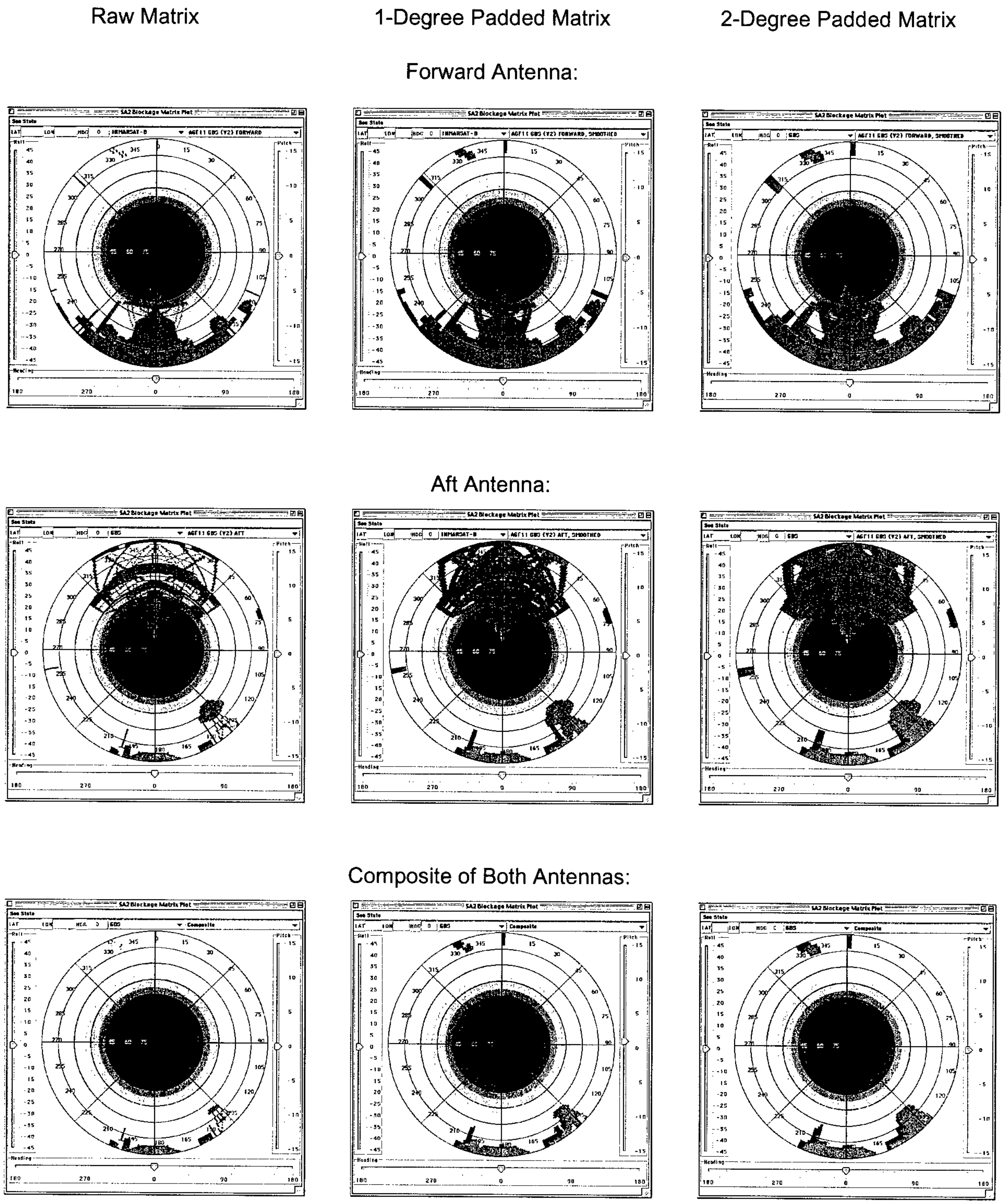

Figure A-1. Blockage plots for the proposed new GBS antenna locations on *Coronado* with varying buffer zones around the actual topside obstructions.

Table A-1. PSU values for the blockage plots shown in figure A-1.

Min. El. Angle	Calm Seas	Sea State 4	Sea State 6
	99.8% (raw)	99.6%	99.1%
	99.6% (1° pad)	99.3%	98.5%
0	99.4% (2° pad)	98.9%	97.9%
	100%	99.9%	99.6%
	100%	99.8%	99.4%
+10	99.9%	99.6%	99.1%

Table A-2. GALA and minimum LALA values for the blockage plots shown in figure A-1 and the satellites UFO 8, 9, and 10.

	GALA	Minimum LALA
Calm	99.8% (raw)	97.5%
	99.6% (1° pad)	95.6%
	99.3% (2° pad)	94.4%
Sea State 4	99.5%	96.7%
	99.1%	93.3%
	98.7%	90.3%
Sea State 6	98.9%	91.1%
	98.2%	86.4%
	97.5%	81.4%

APPENDIX B: E-MAIL CHAIN REPORTING BLOCKAGE IN PEARL HARBOR

This series of e-mails indicates that *Coronado* was experiencing blockage while in port Pearl Harbor during RIMPAC 2000. Audrey Ramirez and Dave Hartzog are the GBS Program Manager and Deputy Program Manager for SPAWAR PMW 176-4, respectively. Ron Perez is the PMW 176-4 focal point for operational support for the GBS Program. Mike Bellando is with the GBS uplink site at Wahiawa, HI. CWO2 Ron Sweigart is the Radio Officer aboard *Coronado.* Alan Stewart is a GBS System Engineer.

```
Date: Wed, 14 Jun 2000 10:55:09 -0700
From: "Perez Ron" <perez_ron@bah.com>
To: Dave Hartzog <hartzogd@spawar.navy.mil>,
   Audrey Ramirez <rameireza@spawar.navy.mil>
CC: John Freeman <jfreeman@spawar.navy.mil>,
   Chris Greeney <greeney_christopher@bah.com>,
   Tricia Ward <ward_patricia@bah.com>, Sue Cassidy <suec@comglobal.com>,
   Dr Roy Axford <axfordra@spawar.navy.mil>, Lee Skeen <skeen@spawar.navy.mil>
Subject: CORONADO GBS SUPPORT INPORT HAWAII

Dave/Audrey,

Below string of email indicates CORONADO may be getting "some field of view to the
satellite" due to one antenna blocked and the other blocked periodically when satel-
lite moves in azimuth in block zone while pierside Pearl.

I hope they remember to "turn on" the blocked antenna that Alan refers too when they
get underway.

The data that I provided Chris yesterday to put together the slide for OPNAV brief
tomorrow is still good regarding CORONADO/MTWHITNEY GBS usage. The below info can be
used as talking points/feedback.

r/ron
---------------------------------------------------------------------
Wed, 14 Jun 2000 10:29:53 -0700 (PDT)
From: "Alan Stewart" <astewart@spawar.navy.mil>
To: "Dan Meier" <dtmeier@msn.com>, "Dan Meier" <dtmeier@raytheon.com>,
        "Mike Bellando" <mpbellando@gbs-pacom.navy.mil>,
        "Sweigart, Ronald E. CWO2 (COR)" <sweigare@coronado.navy.mil>
Date: Wed, 14 Jun 2000 10:30:21 -0700
Subject: Re: Fw: Support
CC: "'Perez Ron'" <perez_ron@bah.com>, "Chuck Hackard" <hackard_charles@bah.com>,
"Alan Stewart" <astewart@spawar.navy.mil>, "Dan Ruffin" <ruffind@nctamspac.navy.mil>,
"Dave Piccus" <piccusdl@cpf.navy.mil>

To clarify, both antennas are inside the antenna blockage zones, so the ACU reports
both antennas blocked. However, one antenna can actually see the satellite most if not
all of the time, as I observed, outside of the actual obstruction (yardarm). I left
the totally blocked antenna turned off, and the other antenna tracking successfully in
port. A status of blocked does not in fact prevent tracking. This was the configura-
tion I briefed out to the tech control people.

As the satellite moves in azimuth during the day, it may move behind the actual
obstruction. I did not remain long enough to know what percentage of time that repre-
sented. I am guessing 75% good.
----------------------------------------------------------------------------
```

On 14 Jun 00, at 7:16, Mike Bellando wrote:

Looks as though the ship is not doing much with GBS while inport for RIMPAC. Do not understand the 99% blockage reported below though. I've been to the ship and one antenna looks definitely blocked (port side). The other one looks to have a clear view to bird. This is/was more or less confirmed by SPAWAR, San Diego's Mr. Alan Stewart who road the ship during transit to Pearl a couple weeks ago and indicates that the ship should be able to see/acquire satellite around 50-75% of time while at pier.

Mike

From: "Sweigart, Ronald E. CWO2 (COR)" <sweigare@coronado.navy.mil>
To: "'Mike Bellando'" <mpbellando@gbs-pacom.navy.mil>
Sent: Tuesday, June 13, 2000 6:29 PM
Subject: RE: Support

Mike,
This time in port, we're blocked about 99% of the time for some reason. I haven't had time to figure out why.
Ron

From: Mike Bellando [SMTP:mpbellando@gbs-pacom.navy.mil]
Sent: Tuesday, June 13, 2000 12:23 PM
To: Sweigart, Ronald E. CWO2 (COR)
Subject: Re: Support

Tks Ron. Are you guys using GBS inport at all? Understand that you can see the satellite about 75% of the time before losing it.
Mike

From: "Sweigart, Ronald E. CWO2 (COR)" <sweigare@coronado.navy.mil>
To: "'Mike Bellando'" <mpbellando@gbs-pacom.navy.mil>
Sent: Monday, June 12, 2000 7:27 PM
Subject: RE: Support

Mike,
I'll ask the J2 folks and let you know. We're underway 20 - 27.
Ron

From: Mike Bellando [SMTP:mpbellando@gbs-pacom.navy.mil]
Sent: Monday, June 12, 2000 1:28 PM
To: Ron Sweigart
Subject: Support

Hello Ron, Mike Bellando here at the Pacific GBS site.

Getting ready here to provide the best GBS support we can for upcoming RIMPAC, and was just wondering how you see that support working during the exercise.

Obviously you will be utilizing the video (CNN, CNN Live) as you have done in the past. How bout the data products that we are currently broadcasting? In the past staff Weax guys have taken good advantage of what we were providing and used information for briefing the Adm, as I understand it.

We are flexible and can modify the current/active product request (good through 13 July) as you or the staff desire.

Understand your antennas are still blocked at the pier. If not classified, can you tell me when the Coronado will be getting u/w.

Tks

Mike

APPENDIX C: GBS SAS DAYFILE FROM 06 JULY 2000

This GBS SAS dayfile was received as an attachment to Sweigart (2000b).

INFO	00:00:00	06 JUL 2000	Dayfile opened
CLEAR	01:31:54	06 JUL 2000	Ant 1 position fault
CLEAR	01:31:54	06 JUL 2000	Ant 2 position fault
CLEAR	01:31:54	06 JUL 2000	Pitch angle sanity fault
CLEAR	01:31:54	06 JUL 2000	Ant 1 movement rate sanity fault
CLEAR	01:31:54	06 JUL 2000	Ant 2 movement rate sanity fault
CLEAR	01:31:54	06 JUL 2000	Pitch rate sanity fault
CLEAR	01:31:54	06 JUL 2000	Ant 1 Lost Track
CLEAR	01:31:54	06 JUL 2000	Heading rate sanity fault
INFO	01:33:03	06 JUL 2000	Prime Calibration Initiated
INFO	01:33:24	06 JUL 2000	Prime Calibration Complete
INFO	01:35:17	06 JUL 2000	Prime Calibration Initiated
INFO	01:35:41	06 JUL 2000	Prime Calibration Initiated
INFO	01:36:02	06 JUL 2000	Prime Calibration Complete
INFO	01:49:37	06 JUL 2000	Prime Calibration Initiated
INFO	01:49:56	06 JUL 2000	Prime Calibration Complete
INFO	02:21:28	06 JUL 2000	Satellite acquired.
INFO	02:37:23	06 JUL 2000	Prime Calibration Initiated
INFO	02:37:44	06 JUL 2000	Prime Calibration Complete
INFO	02:38:48	06 JUL 2000	Prime Calibration Initiated
INFO	02:39:09	06 JUL 2000	Prime Calibration Complete
INFO	02:42:02	06 JUL 2000	Prime Calibration Initiated
INFO	02:42:23	06 JUL 2000	Prime Calibration Complete
INFO	02:49:15	06 JUL 2000	Satellite acquired.
FAULT	02:50:40	06 JUL 2000	Ant 1 Lost Track
INFO	02:52:00	06 JUL 2000	Prime Calibration Initiated
INFO	02:52:21	06 JUL 2000	Prime Calibration Complete
INFO	02:55:54	06 JUL 2000	Prime Calibration Initiated
INFO	02:56:16	06 JUL 2000	Prime Calibration Complete
CLEAR	03:01:22	06 JUL 2000	Ant 1 Lost Track
INFO	03:05:28	06 JUL 2000	Dayfile closed
INFO	03:05:45	06 JUL 2000	Dayfile opened
INFO	03:05:46	06 JUL 2000	GBS-SAS TCPP 1.0.5
INFO	03:06:59	06 JUL 2000	Prime Calibration Initiated
INFO	03:07:20	06 JUL 2000	Prime Calibration Complete
INFO	03:08:32	06 JUL 2000	Satellite acquired.
FAULT	05:48:23	06 JUL 2000	Ant 1 Lost Track
FAULT	05:48:26	06 JUL 2000	Ant 1 position fault
CLEAR	05:52:53	06 JUL 2000	Ant 1 Lost Track
CLEAR	05:52:53	06 JUL 2000	Ant 1 position fault
FAULT	05:53:05	06 JUL 2000	Ant 1 Lost Track
FAULT	05:53:08	06 JUL 2000	Ant 1 position fault
CLEAR	06:10:19	06 JUL 2000	Ant 1 Lost Track
CLEAR	06:10:19	06 JUL 2000	Ant 1 position fault
FAULT	06:10:19	06 JUL 2000	Ant 1 Lost Track
FAULT	06:10:22	06 JUL 2000	Ant 1 position fault
CLEAR	06:10:23	06 JUL 2000	Ant 1 Lost Track
CLEAR	06:10:23	06 JUL 2000	Ant 1 position fault
FAULT	06:10:24	06 JUL 2000	Ant 1 position fault
FAULT	06:10:24	06 JUL 2000	Ant 1 Lost Track
CLEAR	06:10:28	06 JUL 2000	Ant 1 Lost Track
FAULT	06:10:29	06 JUL 2000	Ant 1 Lost Track
CLEAR	06:45:15	06 JUL 2000	Ant 1 position fault
CLEAR	06:45:15	06 JUL 2000	Ant 1 Lost Track
FAULT	06:45:30	06 JUL 2000	Ant 1 Lost Track
FAULT	06:45:32	06 JUL 2000	Ant 1 position fault
CLEAR	06:45:37	06 JUL 2000	Ant 1 Lost Track

CLEAR	06:45:37	06 JUL 2000	Ant 1 position fault
FAULT	06:45:38	06 JUL 2000	Ant 1 position fault
FAULT	06:45:38	06 JUL 2000	Ant 1 Lost Track
CLEAR	06:45:41	06 JUL 2000	Ant 1 position fault
CLEAR	06:45:41	06 JUL 2000	Ant 1 Lost Track
FAULT	06:45:42	06 JUL 2000	Ant 1 position fault
FAULT	06:45:42	06 JUL 2000	Ant 1 Lost Track
CLEAR	06:45:42	06 JUL 2000	Ant 1 position fault
CLEAR	06:45:42	06 JUL 2000	Ant 1 Lost Track
FAULT	06:45:43	06 JUL 2000	Ant 1 position fault
FAULT	06:45:43	06 JUL 2000	Ant 1 Lost Track
CLEAR	06:45:57	06 JUL 2000	Ant 1 position fault
CLEAR	06:45:57	06 JUL 2000	Ant 1 Lost Track
FAULT	06:45:58	06 JUL 2000	Ant 1 position fault
FAULT	06:45:58	06 JUL 2000	Ant 1 Lost Track
CLEAR	06:46:21	06 JUL 2000	Ant 1 position fault
CLEAR	06:46:21	06 JUL 2000	Ant 1 Lost Track
INFO	06:46:39	06 JUL 2000	Prime Calibration Initiated
INFO	06:47:01	06 JUL 2000	Prime Calibration Complete
INFO	06:48:11	06 JUL 2000	Satellite acquired.
FAULT	06:49:39	06 JUL 2000	Ant 1 Lost Track
FAULT	06:49:42	06 JUL 2000	Ant 1 position fault
INFO	09:03:46	06 JUL 2000	GBS-SAS TCPP 1.0.5
FAULT	09:03:52	06 JUL 2000	Ant 1 Lost Track
FAULT	09:03:56	06 JUL 2000	Ant 1 position fault
INFO	10:13:27	06 JUL 2000	Prime Calibration Initiated
INFO	10:13:49	06 JUL 2000	Prime Calibration Complete
CLEAR	10:14:52	06 JUL 2000	Ant 1 Lost Track
CLEAR	10:14:52	06 JUL 2000	Ant 1 position fault
INFO	10:14:59	06 JUL 2000	Satellite acquired.
FAULT	12:18:26	06 JUL 2000	Ant 1 Lost Track
FAULT	12:18:29	06 JUL 2000	Ant 1 position fault
CLEAR	12:30:14	06 JUL 2000	Ant 1 position fault
CLEAR	12:30:14	06 JUL 2000	Ant 1 position fault
CLEAR	12:30:14	06 JUL 2000	Ant 1 position fault
CLEAR	12:30:14	06 JUL 2000	Ant 1 position fault
CLEAR	12:30:14	06 JUL 2000	Ant 1 position fault
CLEAR	12:30:16	06 JUL 2000	Ant 1 Lost Track
CLEAR	12:30:16	06 JUL 2000	Ant 1 Lost Track
INFO	12:31:51	06 JUL 2000	Prime Calibration Initiated
INFO	12:32:12	06 JUL 2000	Prime Calibration Complete
INFO	12:33:23	06 JUL 2000	Satellite acquired.
INFO	14:09:01	06 JUL 2000	Prime Calibration Initiated
INFO	14:09:22	06 JUL 2000	Prime Calibration Complete
INFO	14:10:33	06 JUL 2000	Satellite acquired.
INFO	14:13:14	06 JUL 2000	Prime Calibration Initiated
INFO	14:13:36	06 JUL 2000	Prime Calibration Complete
INFO	14:15:23	06 JUL 2000	Satellite acquired.
FAULT	15:51:42	06 JUL 2000	Ant 2 Lost Track
FAULT	15:51:54	06 JUL 2000	Ant 2 position fault
FAULT	15:52:16	06 JUL 2000	Ant 1 Lost Track
FAULT	15:52:18	06 JUL 2000	Ant 1 position fault
CLEAR	15:58:04	06 JUL 2000	Ant 2 Lost Track
CLEAR	15:58:04	06 JUL 2000	Ant 2 position fault
CLEAR	15:58:04	06 JUL 2000	Ant 1 Lost Track
CLEAR	15:58:04	06 JUL 2000	Ant 1 position fault
FAULT	15:58:04	06 JUL 2000	Ant 1 Lost Track
FAULT	15:58:04	06 JUL 2000	Ant 2 Lost Track
CLEAR	15:58:07	06 JUL 2000	Ant 1 Lost Track
CLEAR	15:58:07	06 JUL 2000	Ant 2 Lost Track
FAULT	15:58:07	06 JUL 2000	Ant 1 Lost Track
FAULT	15:58:07	06 JUL 2000	Ant 2 Lost Track
CLEAR	15:58:25	06 JUL 2000	Ant 1 Lost Track

CLEAR	15:58:25	06 JUL 2000	Ant 2 Lost Track
INFO	15:58:37	06 JUL 2000	Prime Calibration Initiated
INFO	15:58:58	06 JUL 2000	Prime Calibration Complete
INFO	16:00:10	06 JUL 2000	Satellite acquired.
FAULT	16:02:48	06 JUL 2000	Ant 2 Lost Track
FAULT	16:02:56	06 JUL 2000	Ant 1 Lost Track
FAULT	16:02:59	06 JUL 2000	Ant 1 position fault
FAULT	16:02:59	06 JUL 2000	Ant 2 position fault
CLEAR	17:04:58	06 JUL 2000	Ant 2 Lost Track
CLEAR	17:04:58	06 JUL 2000	Ant 1 Lost Track
CLEAR	17:04:58	06 JUL 2000	Ant 1 position fault
CLEAR	17:04:58	06 JUL 2000	Ant 2 position fault
FAULT	17:04:59	06 JUL 2000	Ant 1 Lost Track
FAULT	17:04:59	06 JUL 2000	Ant 2 Lost Track
CLEAR	17:05:02	06 JUL 2000	Ant 1 Lost Track
CLEAR	17:05:02	06 JUL 2000	Ant 2 Lost Track
FAULT	17:05:02	06 JUL 2000	Ant 1 Lost Track
FAULT	17:05:02	06 JUL 2000	Ant 2 Lost Track
CLEAR	17:05:04	06 JUL 2000	Ant 1 Lost Track
CLEAR	17:05:04	06 JUL 2000	Ant 2 Lost Track
FAULT	17:05:05	06 JUL 2000	Ant 1 Lost Track
FAULT	17:05:05	06 JUL 2000	Ant 2 Lost Track
INFO	18:05:17	06 JUL 2000	Prime Calibration Initiated
INFO	18:05:39	06 JUL 2000	Prime Calibration Complete
INFO	18:06:50	06 JUL 2000	Satellite acquired.
FAULT	18:08:54	06 JUL 2000	Ant 1 position fault
FAULT	18:16:52	06 JUL 2000	Ant 2 position fault
CLEAR	19:05:53	06 JUL 2000	Ant 1 Lost Track
CLEAR	19:05:53	06 JUL 2000	Ant 2 Lost Track
CLEAR	19:05:53	06 JUL 2000	Ant 1 position fault
CLEAR	19:05:53	06 JUL 2000	Ant 2 position fault
INFO	19:06:24	06 JUL 2000	Prime Calibration Initiated
INFO	19:06:46	06 JUL 2000	Prime Calibration Complete
INFO	19:07:58	06 JUL 2000	Satellite acquired.
FAULT	19:11:38	06 JUL 2000	Ant 1 Lost Track
FAULT	19:12:42	06 JUL 2000	Ant 1 position fault
CLEAR	19:15:50	06 JUL 2000	Ant 1 Lost Track
CLEAR	19:15:50	06 JUL 2000	Ant 1 position fault
FAULT	19:15:51	06 JUL 2000	Ant 1 Lost Track
FAULT	19:21:55	06 JUL 2000	Ant 1 position fault
FAULT	19:21:55	06 JUL 2000	Ant 2 position fault
FAULT	19:21:56	06 JUL 2000	Ant 2 movement rate sanity fault
CLEAR	20:44:22	06 JUL 2000	Ant 1 Lost Track
CLEAR	20:44:22	06 JUL 2000	Ant 1 position fault
CLEAR	20:44:22	06 JUL 2000	Ant 2 position fault
CLEAR	20:44:22	06 JUL 2000	Ant 2 movement rate sanity fault
INFO	20:45:06	06 JUL 2000	Prime Calibration Initiated
INFO	20:45:28	06 JUL 2000	Prime Calibration Complete
INFO	20:46:40	06 JUL 2000	Satellite acquired.
FAULT	20:55:51	06 JUL 2000	Ant 1 Lost Track
FAULT	20:55:54	06 JUL 2000	Ant 1 position fault
CLEAR	20:58:44	06 JUL 2000	Ant 1 Lost Track
CLEAR	20:58:44	06 JUL 2000	Ant 1 position fault
FAULT	20:59:16	06 JUL 2000	Ant 1 Lost Track
FAULT	20:59:20	06 JUL 2000	Ant 1 position fault
INFO	21:57:04	06 JUL 2000	Ant 2 Shutdown due to APU critical fault
INFO	21:57:04	06 JUL 2000	Prime tracking fault detected
FAULT	21:57:04	06 JUL 2000	Ant 2 cross-level S/D fault. Pwr disabled
CLEAR	23:07:52	06 JUL 2000	Ant 1 Lost Track
CLEAR	23:07:52	06 JUL 2000	Ant 1 position fault
CLEAR	23:07:52	06 JUL 2000	Ant 2 cross-level S/D fault. Pwr disabled
INFO	23:10:00	06 JUL 2000	Ant 1 switched OFF by operator
INFO	23:10:17	06 JUL 2000	Dayfile closed

INFO	23:40:11	06 JUL 2000	Dayfile opened
INFO	23:40:12	06 JUL 2000	----------- TCP reset complete -----------
INFO	23:40:12	06 JUL 2000	GBS-SAS TCPP 1.0.5 / Apr 02 1999 / 08:28:07
FAULT	23:40:12	06 JUL 2000	Beacon PLL Lost Lock Fault
FAULT	23:40:12	06 JUL 2000	Heading rate sanity fault
INFO	23:40:13	06 JUL 2000	GBS-SAS TCPP 1.0.5
CLEAR	23:40:31	06 JUL 2000	Beacon PLL Lost Lock Fault
CLEAR	23:40:31	06 JUL 2000	Heading rate sanity fault
INFO	23:42:10	06 JUL 2000	Ant 1 switched ON by operator
INFO	23:42:10	06 JUL 2000	Ant 2 switched ON by operator
FAULT	23:42:11	06 JUL 2000	Ant 2 movement rate sanity fault
FAULT	23:42:11	06 JUL 2000	Ant 2 cross-level S/D fault. Pwr disabled
CLEAR	23:42:30	06 JUL 2000	Ant 2 movement rate sanity fault
CLEAR	23:42:30	06 JUL 2000	Ant 2 cross-level S/D fault. Pwr disabled
FAULT	23:42:31	06 JUL 2000	Ant 2 movement rate sanity fault
FAULT	23:42:31	06 JUL 2000	Ant 2 cross-level S/D fault. Pwr disabled
FAULT	23:43:09	06 JUL 2000	Ant 2 Slew Timeout fault
INFO	23:43:33	06 JUL 2000	Ant 2 switched ON by operator
CLEAR	23:44:06	06 JUL 2000	Ant 2 movement rate sanity fault
CLEAR	23:44:06	06 JUL 2000	Ant 2 cross-level S/D fault. Pwr disabled
CLEAR	23:44:06	06 JUL 2000	Ant 2 Slew Timeout fault
FAULT	23:44:06	06 JUL 2000	Ant 2 cross-level S/D fault. Pwr disabled
FAULT	23:44:08	06 JUL 2000	Ant 2 movement rate sanity fault
FAULT	23:44:33	06 JUL 2000	Ant 2 Slew Timeout fault
INFO	23:44:56	06 JUL 2000	Prime Calibration Initiated
INFO	23:45:14	06 JUL 2000	Prime Calibration Complete
INFO	23:46:25	06 JUL 2000	Satellite acquired.
INFO	00:00:00	07 JUL 2000	Dayfile closed

APPENDIX D: TROUBLE SHOOTING DATA COLLECTED BY *CORONADO*

This is paragraph 6 from message R111106Z. Unfortunately, *Coronado's* headings were not recorded. It is unclear to the authors of this report what was meant by "Re-Track."

6. THE FOLLOWING SUMMARIZES GBS STATUS DURING TRANSIT FROM HAWAII TO SAN DIEGO:

DATE	TIME(Z)	AZ	EL	SIG-LVL	RE-TRACK	POSIT
08JUL00	1600Z	249.3	32.1	62.3	N	28N 149W
	1615Z	249.0	32.1	33.1	Y	
	1700Z	254.0	56.0	29.9	Y	
	1725Z	255.1	39.4	37.7	Y	
	1735Z	256.4	36.0	29.4	Y	
	1745Z	246.8	33.8	34.6	Y	
	1752Z	252.1	33.8	51.9	Y	
	1810Z	242.8	34.6	37.7	Y	
	1820Z	244.2	30.8	29.4	Y	
	1825Z	246.7	43.7	27.3	Y	
	1832Z	258.0	33.1	37.7	Y	
	1900Z	252.0	32.6	61.7	N	
	1920Z	253.0	32.7	60.0	Y	
	1930Z	252.2	32.2	62.1	Y	
	2000Z	252.3	32.5	62.1	N	
	2100Z	252.3	32.2	61.7	N	
	2300Z	251.1	31.2	61.9	N	
09JUL00	0001Z	249.7	29.8	60.5	N	29N 136W
	0102Z	248.2	28.3	61.4	N	
	0203Z	246.9	27.3	60.4	N	
	0300Z	245.9	26.1	60.4	N	
	0410Z	245.3	25.3	60.5	N	
	0500Z	245.2	25.2	60.7	N	
	0600Z	244.7	24.5	60.8	N	
	0700Z	244.4	24.0	60.9	N	
	0800Z	244.6	23.7	60.9	N	
	0900Z	244.9	23.7	60.4	N	
	1000Z	245.1	23.7	60.4	N	
	1100Z	246.0	23.9	60.8	N	
	1200Z	246.9	24.2	60.2	N	
	1300Z	248.1	24.6	60.0	N	
	1400Z	249.9	25.2	60.4	N	
	1800Z	254.2	26.4	60.1	N	
	2000Z	255.1	26.4	59.7	N	
	2200Z	254.7	25.6	59.2	N	
	2300Z	254.0	24.9	57.9	N	
	2359Z	253.2	24.2	58.3	N	

DATE	TIME	ANT1/ANT2 AZIMUTH	ANT1/ANT2 ELEVATION	ANT1/ANT2 SIG-LVL	RETRACK	POSIT
						30N 132W
10JUL00	0700Z	249.4/247.7	20.5/18.1	59.8/54.0	N/N	
	0800Z	247.7 18.2	60.6/55.2	60.6/55.2	N/N	
	0900Z	248.1/248.2	18.0/18.0	60.7/55.4	N/Y	
	1000Z	248.7/248.7	18.1/17.9	60.7/55.4	N/N	
	1100Z	249.4/249.6	18.3/18.2	60.4/55.4	N/N	
	1200Z	250.5/250.6	18.6/18.6	60.6/56.5	N/N	
	1300Z	251.9/251.9	19.0/18.9	61.1/58.4	N/N	
	1400Z	253.0/253.1	19.4/19.3	60.6/56.4	N/N	
	1500Z	254.0/254.0	19.7/19.8	60.8/56.9	N/N	
	1900Z	257.8/257.8	20.9/20.4	60.4/55.4	N/N	
	2000Z	258.1/257.8	20.7/20.9	59.6/55.9	N/N	
	2100Z	258.0/258.0	20.3/20.1	59.3/55.3	N/N	

DATE	TIME	ANT1/ANT2 AZIMUTH	ANT1/ANT2 ELEVATION	ANT1/ANT2 SIG-LVL	RETRACK	POSIT
						32N 122W
11JUL00	0200Z	254.7/254.7	16.6/16.3	59.2/55.6	N/N	
	0300Z	254.9/254.5	16.2/16.6	50.6/49.1	N/N	
	0400Z	253.5/253.3	15.4/15.3	42.2/42.7	Y/Y	
	0500Z	252.7/252.8	14.1/14.1	47.4/42.1	Y/Y	
	0600Z	252.0/252.1	12.8/13.0	57.8/52.2	Y/Y	
	0700Z	251.6/251.7	13.1/13.1	58.3/51.8	Y/Y	

0800Z	251.6/251.7	13.0/13.1	49.0/49.0	Y/Y	
0900Z	252.3/252.4	12.4/12.1	48.0/49.2	Y/Y	
1000Z	252.8/252.7	12.1/12.1	55.6/55.2	N/N	
1100Z	252.9/253.0	12.2/12.2	56.7/51.5	Y/Y	
1200Z	253.0/252.8	12.3/12.2	46.1/48.4	Y/N	
1300Z	255.1/255.1	13.2/13.2	54.8/50.3	N/N	
1400Z	254.7/255.1	13.4/13.3	53.4/55.7	N/N	
1500Z	256.3/255.5	13.8/13.9	49.3/45.7	N/Y	
1700Z	257.8/257.7	13.9/14.0	36.8/48.5	Y/Y	32N 117W
1800Z	257.9/258.1	14.2/14.0	46.6/57.8	Y/Y	
1900Z	261.5/261.4	14.7/14.7	57.3/57.1	Y/N	
2000Z	257.9/257.9	14.1/14.1	36.7/36.8	Y/Y	
2100Z	257.9/257.9	13.4/13.1	35.3/33.3	Y/Y	
2359Z	(END OF SURVEY)				

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14. ABSTRACT

This report examines the impact of USS *Coronado's* two Global Broadcast Service (GBS) topside antenna locations on the availability of broadcast services. Blockage in the present locations limits *global* average line-of-sight availability (GALA) to 83.7% in calm seas, and to 78.3% and 68.2% in Sea States 4 and 6, respectively. However, the *local* average line-of-sight availability (LALA) for these topside locations drops to ~50% in large regions in the ship's area of responsibility (AOR) and to ~10% in areas around the subsatellite point. Moving one or both of the antennas to alternative locations can improve these results. This report also presents GALA and LALA results for a proposed new pair of antenna locations for which the LALA never drops below 81.4% at any point in the field-of-regard of the UHF Follow-On (UFO)/GBS satellites for Sea State 6. Since associated topside electromagnetic compatibility (EMC) studies have been completed with positive results, we recommend that *Coronado's* GBS antennas be moved to these new positions.

15. SUBJECT TERMS

Mission Area: Communications
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USS *Coronado*

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